Managerial Economics
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Lecture - 63
Oligopoly (Contd…)

So, we will be continuing our discussion on non-collusive oligopoly model also in this session. So, if you remember in the last class, we discussed about the Cournot models, and Cournot models typically is a duopoly market situation, where the basic characteristic is that it operates in zero cost of production, and that is why we get a marginal cost which is equal to 0. Here, even if the firm, they knows that they are interdependent on each other, but when they fix their output, when they fix their price, they are not taking into consideration, what will be the rivals plan on the basics of their revised plan.

That is the reason if you remember in last class we discussed a situation when in the period one-fourth of the market remained unexplored. No one produced in that one-fourth market. Rest three-fourth market got produced by both the firms a and b. So, we will continue our discussion on the Cournot model. We will see that how the equilibrium solution can be achieved or how the equilibrium can be achieved with the reaction and action patterns of the reaction and action pattern of the two firms.

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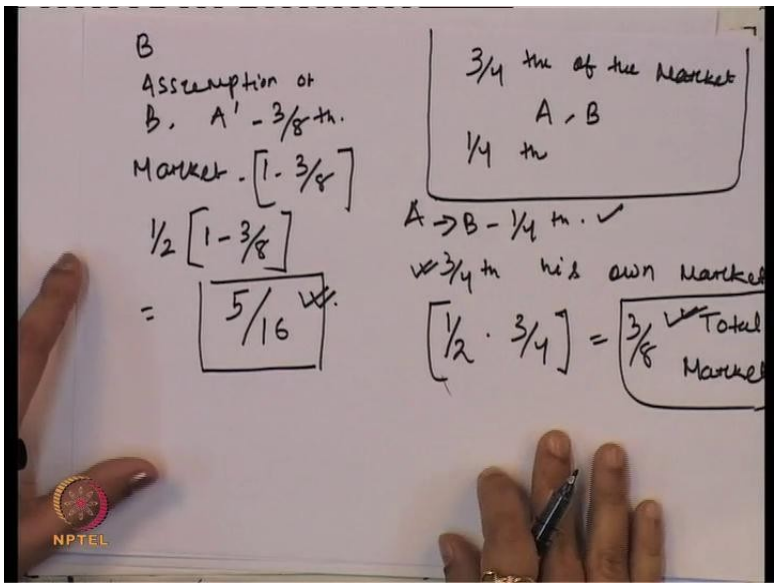

So, in the last class, if you remember we talked about a situation where the three-fourth of the market generally. So, in that case if you remember, then A, B together they were just producing three-fourth of the market and one-fourth was not produced either by firm A or firm B, at least in the first period. Now, what will happen in period 2? So, this in the first case, three-fourth was produced together by A and B and one-fourth was not.

Now, how it will happen? In period two firms A assume that B is just going to produce one-fourth of it and he will feel that three-fourth is his own market typically for firm A. So, if three-fourth is his own market, now generally he is producing only half of it. So, he will produce half of three-fourth in the market and that will come to three-eighth of total market.

So, A is going to produce three-eighth of total market. A assume that B is just going to produce one-fourth of the market. So, A will think that he is just going to produce only three-fourth and the rest three-fourth is own market and since A produces only half of the total market. In this case, the half of total market is half multiplied by three-fourth and that comes to 3 by 8 as the total market.

Now, we will see how B is going to react to this. So, B will consider that again when it comes to B, what will be the assumption? The assumption for B is A will continue to produce three-eighth of the market means what is the market available for B, the remaining market that is less by $3/8$. So, this is $\left[1.\frac{3}{8}\right]$ is the market available to B. Now, B will produce again half of this because $\frac{1}{2}\left[1.\frac{3}{8}\right]=\frac{5}{16}$. So, A is going to produce $3/8$. and B is going to produce $\frac{5}{16}$.

Now, this action reaction pattern continues. Firm always assume that, A always assume that B is going to produce half and firm B is always going to assume that A is going to produce half. So, they take out that half and they feel that the rest of the market, whatever they could produce and again, it becomes the half of the total market demand. So, this action reaction pattern for firm A and B will continue.

Now, what is the outcome of this action reaction pattern of firm A and B? So, it just goes on with the share that is half of share, half of the total market except the share of A for B and half of the total market except the share of B for A. So, this action reaction will continue.

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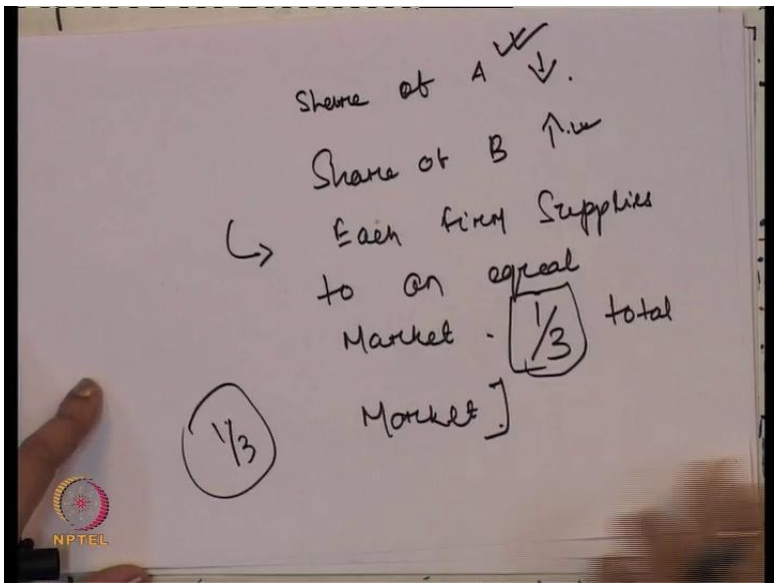

So, in this action reaction, generally share of A goes on decreasing and share of B goes on increasing and this will lead to a situation where each firm supply's to an equal market that is one-third of the total market. So, this if you look at initially the share of A was higher than share of B. So, this action reaction pattern will continue and with the action reaction pattern, finally each firm will reach to a situation where they are just producing one-third of the total market and remaining this one-third of total market is produced by a one-third of total market is produced by B and remaining one-third is not getting produced either by A or by B. So, we will just take the graph to understand this that how this will reach to a situation where they just produce one-third and leads to a case, where rest one-third remain on produce either by A and B.

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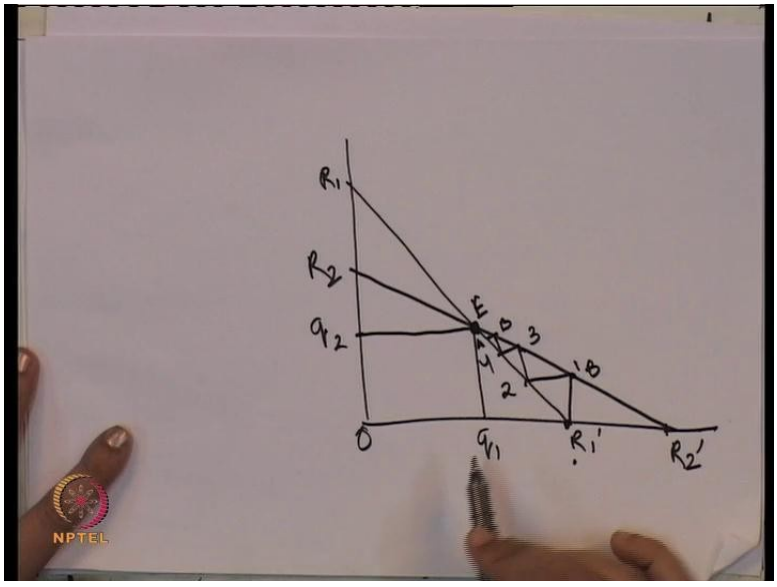

So, if you remember, your reaction function R_1. R_1 does is the reaction function of firm A. R_2 does is the reaction function of firm B. So, ideally this should be the situation where this is the amount of q_1 , this is the amount of q_2,$q_1$is produced by A, q_2 is produced by B. Now, how they reached to this $q_1 A$ to $q_1 B$? It is not that they start from here, rather they started from here. What is this R_1 does here at this point? The total market demand is we can say R_2 does is the total market demand. So, out of this, initially A will just produce this much and from there, actually this action reaction pattern happen. So, if this A is producing this, corresponding to this B will produce here that in the reaction curve of B R_2. R_2 does is the reaction curve function of B. R_1, R_1 is the reaction curve function of A.

So, if you look at, initially A produce this much. Now, with reaction to this B will produce take a point corresponding to this in the reaction function of B that is R_2 or this corresponding to this. Again, A will react to this and choose a combination, where in the reaction function of A and if you remember, what is reaction function. Reaction function gives the different quantity of q_1 and q_2 combinations of q_1 and q_2, where profit is maximum. So, whether B chooses any y combination and reaction function to A chooses any combination and reaction function one, ideally they maximize the profit.

So, to start with, they will do this with a start with this point corresponding to this B, choose a combination over here. Now, suppose this is combination 1. Then, this is combination 2 again chosen by A with respect to the reaction to a combination B by this one. Then, corresponding to this, again B will choose a combination here and corresponding to this, A will choose a combination here. Then, corresponding to this, again B will choose a combination here and here will choose a combination. Here, this action reaction will continue till the time they are not reaching this point E and after reaching the point E, they generally reach the equilibrium solution where A produce q_1 unit of output and B produce q_2 unit of output.

So, graphically how we reach the Cournot's equilibrium? We reach the Cournot equilibrium through the reaction function approach. We take the reaction function 1, reaction function 2 and the reaction of both the firms get capture in their own reaction function. Finally, eventually this reaction action pattern leads them to the equilibrium where this is generally stable and after that, at least in that time period again the reaction action pattern never continue. Then, we will see the detail description that how this one-third of this total market

output comes to firm 1. We will just take period wise that how this finally comes to one-third for firm A and one-third firm B.

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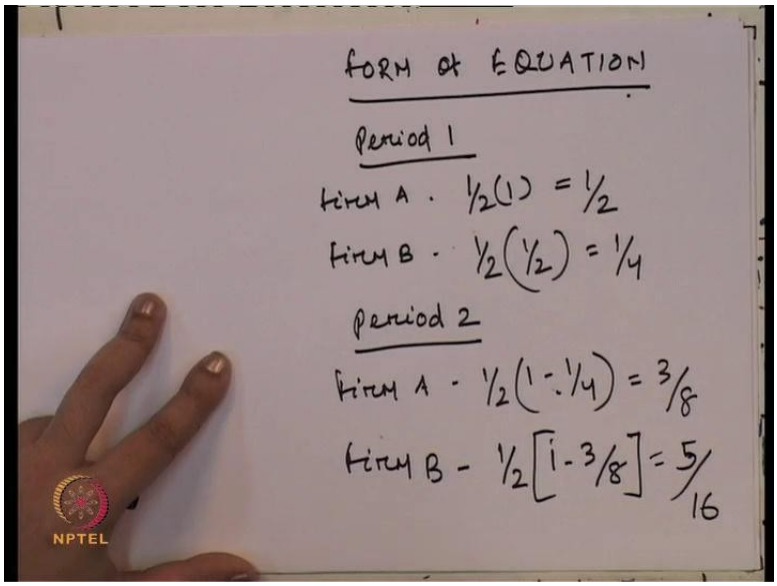

So, generally we will just take a form of equation in order to understand this. So, period 1, we will see what is firm A, what is firm B. So, firm A is half of total market. So, this is half, firm B is half of half market that is a share that comes to one-fourth. Then, period What will be for firm A $\frac{1}{2}\left[1-\frac{1}{4}\right]$. $\frac{1}{4}$is the B share that comes to $\frac{3}{8}$. Then, what will be for firm B that is $\frac{1}{2}\left[1-\frac{3}{8}\right]=\frac{5}{16}$.

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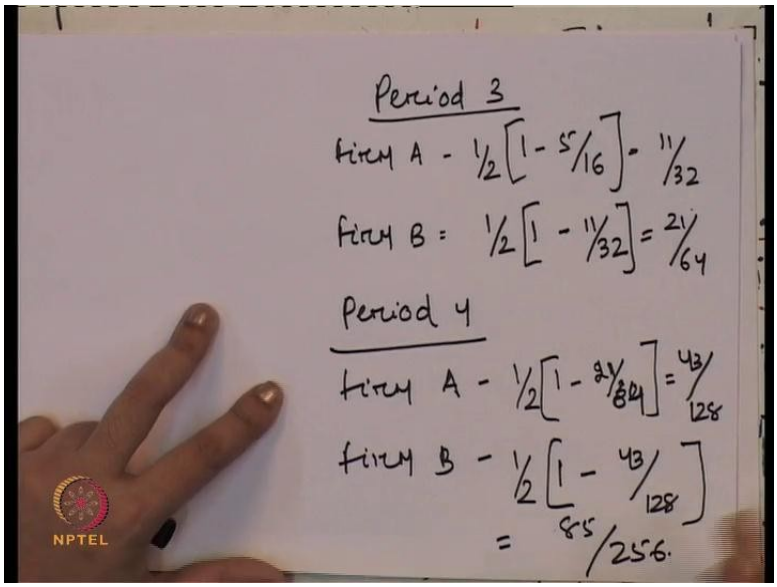

Now, what will be in period 3 firm A that is $\frac{1}{2}\left[1-\frac{5}{16}=\frac{11}{32}\right]$. This is B share that comes to 11 by 32. So, this is B share 1 minus this half of it going to be produced by firm A. Firm B again $\frac{1}{2}\left[1-\frac{11}{32}\right]=\frac{21}{64}$. This is share of A. So, this comes to 21 by 64. Then, we will talk about period 4 output of firm A and firm B.

So, this is nothing, but just taking the share and making half of it, but eventually we will see how this has produced one-third of the total output. So, for period 4, this is again $\frac{1}{2}\left[1-\frac{21}{64}\right]=\frac{43}{128}$. So, that comes to 43 divided by 128 and firm B again $\frac{1}{2}\left[1-\frac{43}{128}\right]=\frac{85}{256}$. Now, this continues till the time period end. So, we will see how what will be the value in period N because N takes any number. So, it is 1 to n.

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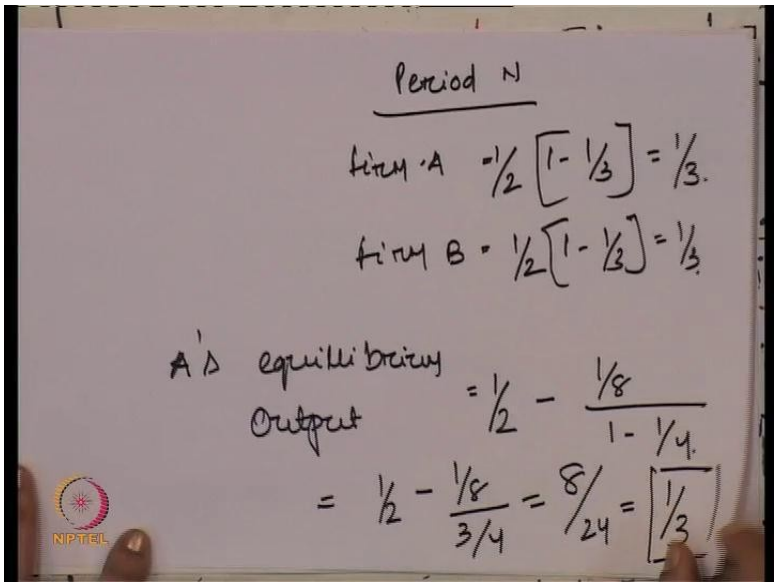

So, in period N what will be the share of firm A? Firm B. Eventually, it is firm A $\frac{1}{2}\left[1-\frac{1}{3}\right]=\frac{1}{3}$ that comes to 1 by 3 and firm B $\frac{1}{2}\left[1-\frac{1}{3}\right]=\frac{1}{3}$ that is coming to 1 by 3. Now, what

is a equilibrium output? Now, A's equilibrium output will be $\left[\frac{1}{2}-\frac{\frac{1}{8}}{1-\frac{1}{4}}\right]$. So, that comes to

$\left[\frac{1}{2}-\frac{\frac{1}{8}}{\frac{3}{4}}\right]=\frac{8}{24}=\frac{1}{3}$. This is firm A equilibrium output.

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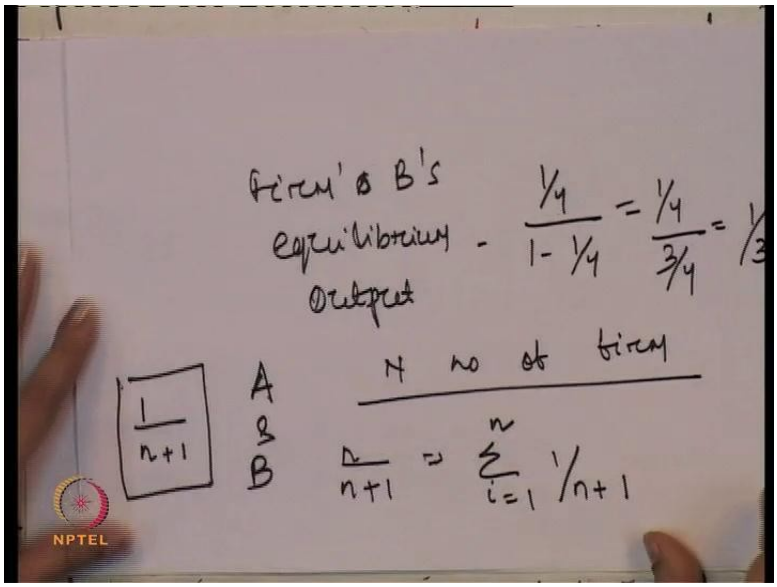

Similarly, we will find firm B's equilibrium output. So, firm B's equilibrium output o

$\frac{\frac{1}{4}}{1-\frac{1}{4}}=\frac{\frac{1}{4}}{\frac{3}{4}}=\frac{1}{3}$. and for N number of firm what will be the industry output and what will be

the firms output. Industry Output will be $\frac{n}{n+1}=\sum_{i=1}^{n}\frac{1}{n+1}$. What will be the individual firms

output? $\frac{n}{n+1}$. This will be the individual firms output both for A and B.

So, ideally what we want to check over here? We want to check over here is that when the action reaction pattern happens, they assume the same behavior from other firms and that is why, if you find some of this remain on utilize that is not being produced either by firm A or firm B and that is why they are just producing one-third of the total output of the market and remaining one-third is not being produced either by A and B.

Next, we will see, we will just take an example to understand this Cournot model. We will just take a numerical to understand the Cournot's model then and then, we will move into the next model that is Stackelberg's model and Paul Sweezy kinked demand curve model.

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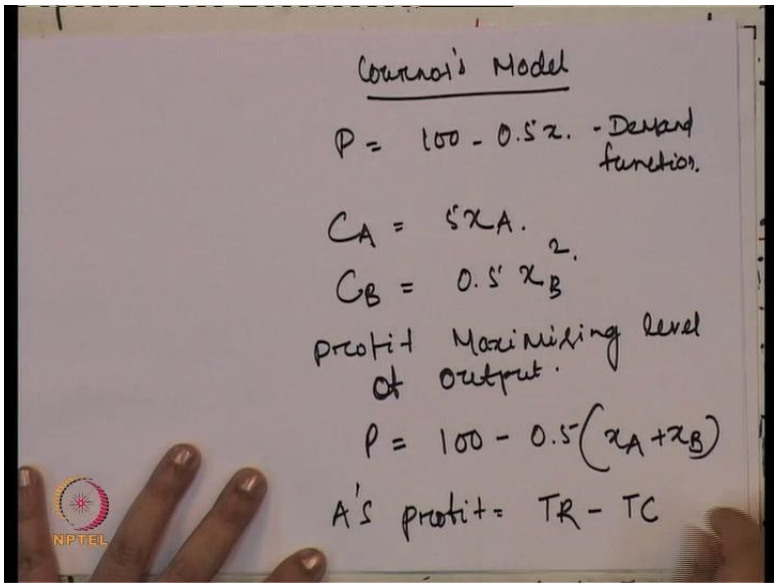

So, $P=100-0.5x$. This is the demand function, this is cost function of firm A which is a cost and cost function for firm B. It is the increasing cost function. We need to find out the profit maximizing level of output for both the firm A and B. How we will find out this? We generally take the profit maximizing rule that is marginal revenue is equal to marginal cost.

So, what is this P? P, we can simplify this is as $P=100-0.5(x_A+x_B)$ because this $x=(x_A+x_B)$ is the total output is the summation of output of A and B. What will be the profit of A? What will the profit of firm A? That is total revenue minus total cost $\pi_A=TR-TC$. What is total revenue over here?

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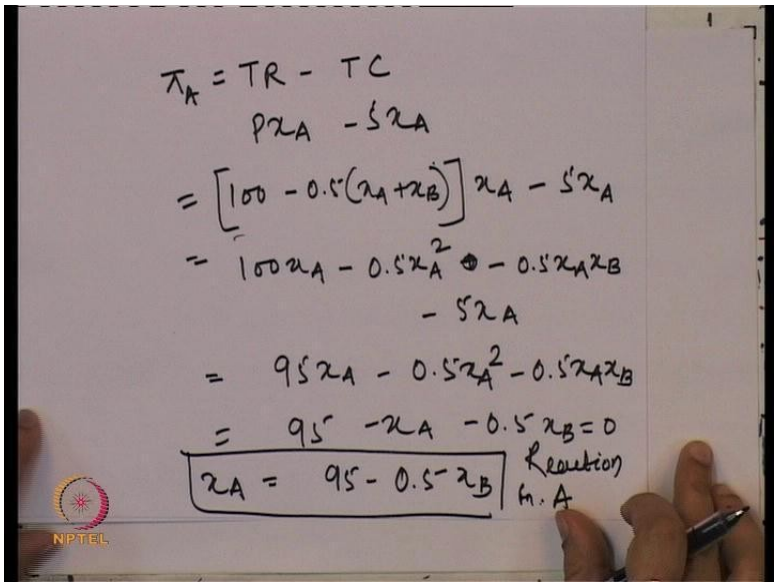

So, total revenue minus total cost will give us the profit of A. So, this is $\pi_A = P\,x_A - 5\,x_A$. This is the output, this is the price minus $5\,x_A$, this is the cost function of the firm A. So, what is $P\,x_A$? That is $\pi_A = \left[100 - 0.5\left(x_A + x_B\right)\right] x_A - 5\,x_A$. So, this is cost function, this is P and this x A. So, if you simplify this, then it comes to $100\,x_A - 0.5\,x_A^2 - 0.5\,x_A\,x_B - 5\,x_A$. Simplifying this again, this is $95\,x_A - 0.5\,x_A^2 - 0.5\,x_A\,x_B$

So, this is our marginal that is our profit. So, this comes to marginal revenue equal to minus marginal cost has to be equal to 0. So, this is 95. If you take the derivative, then this comes to 95. This comes to x_A, this comes to $0.5\,x_B$.. So, if you simplify this in term of x_A, this comes as $x_A = 95 - 0.5\,x_B$. What is this $x_A =$¿in term of x_B.? This is the reaction function of A and this is the reaction function of A.

Similarly, we will find the reaction function of B and if you remember, what is the reaction function of A. This combination gives the maximum level of profit to the firm A. Similarly, we will now find it for B.

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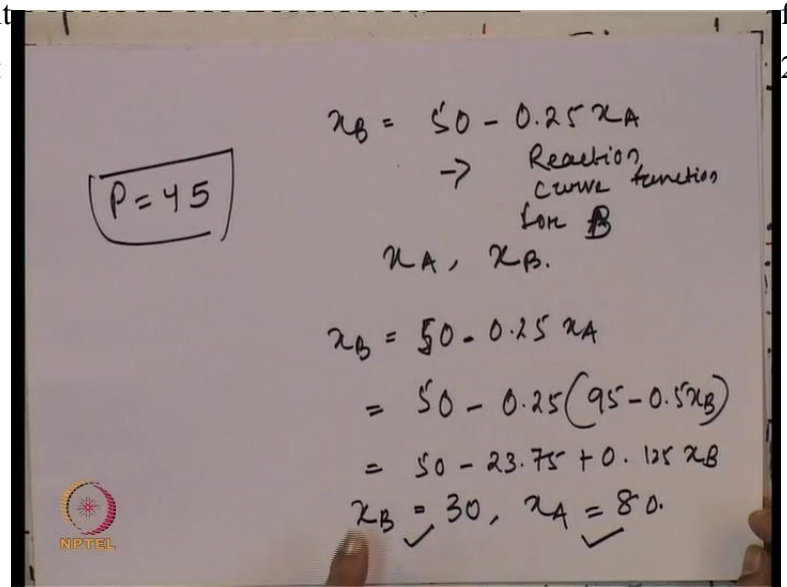


So, if this for x_B, we ge$x_B = 50 - 0.25 x_A$t is . So, I am not just doing a detail calculation for B. You will need to follow the same formula to find out what we did for A, the same formula to find out the reaction curve function for B. Basically, you need to find out the pi. Then, you need to maximize it. The pi is the difference between total revenue total cost. You need to maximize this and then, solve for the value in term of x_B, in term of x_A and that will give us the reaction curve function for reaction curve function for B.

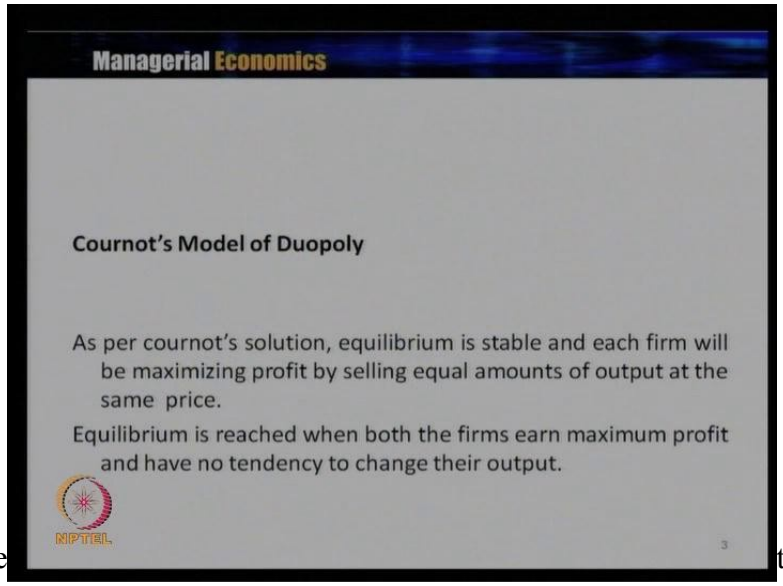
Now, to find this value of x_A and x_B, we need to put the reaction curve function of B in A and reaction and we can solve the value of x_A. So, in this case, we can find out $x_B = 50 - 0.25 x_A$. So, now what we will do? We will put the value ofx_A in order to solve for x_B. So, this is equal to $x_B = 50 - 0.25(95 - 0.5 x_B)$. So, that comes to $x_B = 50 - 23.75 + 0.125 x_B$.

So, solving for this x_B will be equal to 30, x_A is equal to 80 and putting a value of x_A and x_B, that is 80 plus 30 that comes to 120 and putting the value of this, we will get the value of P which is equal to 45. So, this is the output of the B, this the output of A and this is profit maximizing level of output of A and B using the Cournot model or generally using the reaction curve approach.

So, what we discuss of in case of Cournot model, this is a typical situation where two firms engage with each other. They know the interdependence, but they are not considering the fact that they are interdependent to each other in order to decide the output plan and that is the reason, when they are revising their plan. They are not considering what will be the rivals reaction to the revised plan and ultimately, they are reaching to a equilibrium which is stable, but in that case, they are not exploring the output to enter the market.

Here, we take the assumption that there is zero cost of production and we also discuss in case of Cournot model that when we assume the zero cost and there is a linear demand curve, the output of perfect, the output of monopoly is half of competitive output and duopoly output is the two-third of competitive output. So, to summarize this as per Cournot solution,

equilibrium is stable and each firm will be maximizing profit by selling equal amount of output at the same price. (Refer Slide Time: 24:56)



So, price same they are selling the equal amount of output like one-third of the total market and equilibrium is reached when both the firm earns maximum profit and have no tendency to change their output.